



UNITED STATES DEPARTMENT OF COMMERCE
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NATIONAL MARINE FISHERIES SERVICE
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CRUISE RESULTS

NOAA Vessel Miller Freeman, Cruise 91-12
1991 Alaska Fisheries Science Center
West Coast Upper Continental Slope
Groundfish Trawl Survey
October 21 to November 18, 1991

A bottom trawl survey of the groundfish resources of the upper continental slope was completed by Alaska Fisheries Science Center (AFSC) scientists aboard the NOAA research vessel Miller Freeman between October 21 and November 18, 1991. The survey covered the upper continental slope waters 550 to 732 m deep in the International North Pacific Fisheries Commission (INPFC) Columbia (lat 45°21'N to 44°07'N) and Eureka (lat 42°55'N to 40°32'N) statistical areas and slope waters 183 to 1,280 m deep in the INPFC Monterey statistical area (lat 40°30'N to 38°20'N) (Figure 1). This report summarizes the preliminary results of the survey.

OBJECTIVES

The primary objectives of the 1991 groundfish trawl survey were:

1. to resurvey stations in waters 550 to 732 m deep which were sampled by the Miller Freeman during the 1989 and 1990 continental slope surveys of the INPFC Columbia and Eureka areas to investigate a sharp decline in sablefish, Anoplopoma fimbria, and thornyhead, Sebastolobus spp., catch rates between the southern Columbia area in 1989 and the Eureka area in 1990--the resurvey also provides a link among surveys performed in adjacent areas over several years;
2. to extend the assessment of abundance and distribution of key upper continental slope groundfish species, especially sablefish; Dover sole, Microstomus pacificus; shortspine thornyhead, Sebastolobus alascanus; longspine thornyhead, S. altivelis; arrowtooth flounder, Atheresthes stomias; and key slope rockfish (Sebastes sp.) species to the INPFC Monterey area;



3. to obtain extensive biological data, including sex, length, age, length-weight, and maturity, from target species and to collect data relating sablefish flesh firmness and external color to their depth of capture, size, and age; and
4. to obtain stomach samples from Dover sole; sablefish; Pacific hake, Merluccius productus; deepsea sole, Embassichthys bathybius; and shortspine and longspine thornyhead for use in investigations of the trophic relationships of the community.

Additional projects were conducted to continue studies of juvenile sablefish movements through tagging and to describe the temperature and salinity characteristics of the slope habitat. Whole fish and frozen tissue samples were collected from shortbelly rockfish, Sebastes jordani, captured at four stations near the 183-m contour in Pioneer Canyon (lat 37°18'N, long 122°50'W) for an ongoing fecundity investigation being conducted by Southwest Fisheries Science Center (SWFSC), Tiburon Laboratory, scientists. Opportunistic plankton samples were collected from seven stations between Cape Disappointment (lat 46°17'N, long 124°16'W) and Point Grenville (lat 47°14'N, long 124°32'W), Washington, to assist Northwest Fisheries Science Center (NWFS) investigations concerning the recent occurrence of domoic acid toxin in west coast shellfish populations.

VESSEL AND GEAR

The research vessel Miller Freeman is a 65.5-m (215-ft) stern trawler equipped with modern trawling, oceanographic, and hydrographic sampling systems and navigation and fishing electronics. The standard survey trawl used was the polyethylene high-opening Noreastern bottom trawl equipped with mud-sweep roller gear constructed of 203-mm (8-in) solid rubber disks strung on 16-mm high tensile chain. Dimensions of this net are: 27.2-m (89-ft) headrope; 37.4-m (123-ft) footrope, including the "flying wings"; body constructed of 127-mm stretched mesh polyethylene netting; 89-mm stretched mesh codend; and a 32-mm stretched mesh codend liner. Each wing was attached to a 907-kg (2,000-lb), 1.8 x 2.7-m (6 x 9-ft) steel V-door by three 55-m (180-ft) dandyline made of 16-mm galvanized steel cable. A SCANMAR¹ acoustic trawl mensuration system was used to obtain mean fishing dimensions of the Noreastern trawl and a Furuno wireless netsonde system was used to monitor bottom contact throughout each trawl haul.

¹ Use of commercial name does not imply endorsement by the National Marine Fisheries Service.

Water column temperature and salinity profiles were obtained using a Seabird Seacat SBE19 CTD probe and with expendable bathythermograph (XBT) probes.

SURVEY DESIGN AND METHODS

During previous surveys of the INPFC Columbia (1989) and Eureka (1990) areas, catch rates of sablefish and thornyheads in the 549 to 732-m depth stratum dropped abruptly at the more southern stations. In 1991, 27 stations in this depth stratum were resurveyed to determine whether this was an anomaly.

The INPFC Monterey area (lat 40°30'N to 38°20'N) was stratified into six depth strata: 183 to 366, 367 to 549, 550 to 732, 733 to 914, 915 to 1,097, and 1,098 to 1,280 m (100 to 199, 200 to 299, 300 to 399, 400 to 499, 500 to 599, and 600 to 699 fm). Trawl station sites were placed randomly along 14 east-west tracklines situated 16.7 km (9 nm) apart in each of the six Monterey area depth strata. The number of stations per depth stratum were allocated proportionally to the trackline length across each stratum as follows:

<u>Linear distance along trackline within each depth stratum</u>	<u>Number of stations allocated to each section of trackline</u>
≤7.1 nm (13.0 km)	1
7.1–14.0 nm (13.1–25.9 km)	2
≥14.1 nm (26.1 km)	3

At least one trawl station was assigned to each Monterey area depth stratum along each trackline.

Stations were surveyed with the ship's fathometer and Global Positioning System (GPS) plotter before and during net deployment. Sampling at each station consisted of a controlled bottom trawl haul with a netsonde attached to the headrope to monitor bottom contact. A CTD cast was made at shallow, intermediate, and deep stations on each trackline to obtain temperature and salinity profiles of the slope water column. XBT casts were made at sites not sampled with CTD casts. After the trawl settled to the bottom, it was towed for 30 minutes at depths shallower than 732 m (400 fm) using a scope ratio of approximately 2.5:1. Sixty-minute hauls were made at deeper stations using scope ratios of approximately 2:1. Towing speed was approximately 2 knots at all stations and trawling operations occurred 24 hours per day. Trawl fishing dimensions were monitored at

all stations shallower than 1,097 m. Station data, including time, position, trawl dimensions, distance fished, salinity and temperature profiles, and catch and length information, were stored for later analysis using shipboard computer systems.

All catches were sorted to the lowest possible taxon, weighed, counted, and processed according to standard AFSC protocols. Samples of each fish species caught in every haul were measured for length composition. Otolith (age) samples by sex-centimeter category and other biological data were collected from the major fish species encountered. Special study collections were stored in appropriate fixatives or frozen. No biological data were obtained from the resurvey stations.

RESULTS

INPFC Columbia and Eureka Area Resurvey

Trawl samples were obtained from each of 10 stations in the Columbia area and from 16 of 17 stations in the Eureka area. One station was abandoned when the ground was determined to be untrawlable. The 20 most abundant groundfish and crab species taken from successful tows in each area, ranked in order of mean catch per unit effort (CPUE) expressed in kg/km trawled, are shown in Table 1. In 1990, mean catch rates of sablefish and longspine thornyhead in the Eureka area were lower than were observed in the 1989 Columbia area. In 1991, mean catch rates of sablefish, longspine thornyhead, and Dover sole were higher in the Eureka resurvey area than in the Columbia resurvey area, whereas mean catch rates of shortspine thornyhead were higher in the Columbia resurvey area. Catch rates of sablefish, longspine thornyhead, and Dover sole in the Columbia resurvey area dropped dramatically between 1989 and 1991 while catch rates for shortspine thornyhead were somewhat higher in 1991 (Figure 2).

INPFC Monterey Area Survey

Successful trawl samples were obtained from 70 of 73 Monterey area stations. Some pre-selected stations were moved slightly to more suitable terrain for trawling. Six stations on one trackline and three on an adjacent trackline could not be fished due to the presence of submarine telephone cables. The three unsuccessful Monterey area tows resulted in extensive damage to the net. The mean CPUEs of the 20 most abundant groundfish and crab species taken from successful tows in each depth stratum are shown in Table 2. Mean CPUE distributions by depth stratum and relative abundance over all depth strata are summarized for the five target groundfish species and grooved Tanner crab in Figure 3.

Dover sole was the most abundant species overall in the Monterey area. It was taken in all strata, was the most abundant species in the 367 to 549 and 550 to 732-m strata (87.7 and 48.7 kg/km, respectively) and was among the four most abundant species in three of the other four depth strata. Sablefish was taken in each depth stratum. It was the second most abundant species (27.7 kg/km) in the 915 to 1,097-m stratum and the third most abundant species in the 367 to 549-m and 550 to 732-m strata (16.9 and 29.7 kg/km, respectively). Longspine thornyhead was taken in all except the shallowest (183 to 366 m) stratum and was the most abundant species in the 733 to 914-m and 915 to 1,097-m strata (78.4 and 69.7 kg/km, respectively). Longspine thornyhead was also the second most abundant species in the 550 to 732-m stratum. Shortspine thornyhead was taken in all strata and was most abundant in the 915 to 1,097-m stratum (16.4 kg/km). Shortspine thornyhead was the fifth or sixth most abundant species in three of the other five strata. Arrowtooth flounder was not among the 20 most abundant groundfish species in any of the depth strata surveyed. Grooved Tanner crab was taken in each depth stratum and was most abundant in the 1,098 to 1,280-m stratum (24.0 kg/km).

Otoliths and data on individual length, weight, and maturity stage were collected from sablefish, Dover sole, arrowtooth flounder, and shortspine and longspine thornyhead. A total of 812 stomach samples were collected from six slope groundfish species for feeding habits studies and 83 juvenile sablefish were tagged and released in good condition in the study area. Additionally, 34 CTD and 47 XBT water column profiles were obtained. A summary of the biological data collected during the survey is shown in Table 3 and Table 4 summarizes the length-frequency data collected from non-target species.

Shortbelly Rockfish Fecundity Specimen Collections

In cooperation with the SWFSC's Tiburon Laboratory researchers, four trawl hauls were made in Pioneer Canyon off San Francisco, California, to collect 300 tissue and whole fish samples from shortbelly rockfish for fecundity analyses.

Domoic Acid Plankton Sampling

Additionally, seven opportunistic 30-m deep oblique plankton tow samples were obtained at 10-m intervals from waters between Cape Disappointment and Point Grenville, Washington. The plankton samples were obtained with a 303 micron, 60-cm diameter bongo net and were preserved in 5% formalin. CTD casts were made at the first, fourth, and seventh plankton sampling stations.

SCIENTIFIC PERSONNEL

Leg I (October 21 to November 3)

Frank Shaw, Chief Scientist	AFSC, Seattle
Dennis Benjamin	AFSC, Seattle
Robert Lauth	AFSC, Seattle
Marija Vojkovich	CDFG, Long Beach
William Flerx	AFSC, Seattle
Gary Mundell	AFSC, Seattle
Allison Ward	AFSC, Seattle
Dave King	AFSC, Seattle
Daniel Decker	AFSC, Seattle
Leanne Powell	AFSC, Seattle
Lynn Faughnan	AFSC, Seattle

Leg II (November 4 to 18)

Paul Raymore, Chief Scientist	AFSC, Seattle
Ken Weinberg	AFSC, Seattle
James Smart	AFSC, Seattle
William Flerx	AFSC, Seattle
Gary Mundell	AFSC, Seattle
Allison Ward	AFSC, Seattle
Larry Haaga	AFSC, Seattle
Daniel Decker	AFSC, Seattle
Leanne Powell	AFSC, Seattle
Dan Nichol	AFSC, Seattle
Brian Jarvis	SWFSC, Tiburon

AFSC = Alaska Fisheries Science Center, Seattle, Washington

CDFG = California Department of Fish and Game,
Long Beach, California

SWFSC = Southwest Fisheries Science Center, Tiburon, California

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Table 1.--Mean CPUE (kg/km trawled) of the 20 most abundant groundfish and selected crab species caught during the 1991 west coast upper continental slope groundfish resurvey of the INPFC Columbia and Eureka statistical areas in the 300-399 fm depth stratum.

Columbia Area (10 tows; 16.4 km trawled)		Eureka Area (16 tows; 29.0 km trawled)	
Species	Mean CPUE	Species	Mean CPUE
Shortspine thornyhead	42.4	Longspine thornyhead	58.7
Dover sole	30.2	Dover sole	47.8
Longspine thornyhead	29.7	Sablefish	35.1
Sablefish	24.7	Grooved Tanner crab	31.8
Pacific hake	23.2	Shortspine thornyhead	13.7
Longnose skate	12.2	Rex sole	11.6
Grooved Tanner crab	6.2	Giant grenadier	11.6
Rex sole	2.7	Black eelpout	3.5
Giant grenadier	2.7	Pacific hake	2.2
Brown cat shark	1.6	Brown cat shark	1.9
Black eelpout	1.5	Deepsea sole	1.7
Sandpaper skate	1.2	California slickhead	1.2
Twoline eelpout	1.1	Twoline eelpout	1.1
Black hagfish	1.0	Black skate	1.1
Black skate	0.9	Pacific grenadier	0.9
Snailfish unidentified	0.3	Black hagfish	0.8
Deepsea sole	0.2	Kamchatka flounder	0.5
Pacific grenadier	0.2	King-of-the-salmon	0.4
Pacific flatnose	0.2	Bigfin eelpout	0.4
Arrowtooth flounder	0.2	Longnose skate	0.3

Table 2.--Mean CPUE (kg/km trawled) of the 20 most abundant groundfish and selected crab species caught during the 1991 west coast upper continental slope groundfish survey of the INPFC Monterey area.

Species name	Stratum 1 183—366m	Species name	Stratum 2 367—549m	Species name	Stratum 3 550—732m	Species name	Stratum 4 733—914m
Pacific hake	47.6	Dover sole	87.7	Dover sole	48.7	Longspine thornyhead	78.4
Splitnose rockfish	25.5	Pacific hake	81.8	Longspine thornyhead	36.4	Dover sole	33.2
Shortbelly rockfish	23.5	Sablefish	16.9	Sablefish	29.7	Grooved Tanner crab	9.9
Dover sole	19.7	Rex sole	13.6	Grooved Tanner crab	12.7	Sablefish	6.5
Chilipepper rockfish	19.4	Longnose skate	6.9	Pacific hake	11.9	Shortspine thornyhead	5.6
Sablefish	15.7	Aurora rockfish	6.2	Shortspine thornyhead	10.6	California slickhead	4.7
Sharpchin rockfish	11.5	Shortspine thornyhead	6.1	Brown cat shark	4.3	Giant grenadier	3.8
Rex sole	10.7	Longspine thornyhead	5.2	Giant grenadier	4.1	Deepsea sole	2.3
Stripetail rockfish	10.2	Spiny dogfish	4.8	Twoline eelpout	2.6	Brown cat shark	1.2
English sole	7.2	Bigfin eelpout	4.8	Black eelpout	1.3	Pacific grenadier	1.2
Spotted ratfish	6.6	Spotted ratfish	4.4	California slickhead	1.3	Black hagfish	0.7
Darkblotched rockfish	6.4	Sandpaper skate	3.4	Longnose skate	1.1	Blacksmelt unidentified	0.4
Longnose skate	6.0	Brown cat shark	2.1	Pacific grenadier	1.1	Twoline eelpout	0.4
Bigfin eelpout	3.6	Blackgill rockfish	2.1	Deepsea sole	1.0	Kamchatka eelpout	0.3
Slender sole	3.3	English sole	1.2	Black hagfish	0.7	Threadfin slickhead	0.3
Shortspine thornyhead	2.7	Black eelpout	1.0	Black skate	0.5	Black eelpout	0.1
Spiny dogfish	2.2	Slender sole	0.9	Aurora rockfish	0.4	Black skate	0.1
Sandpaper skate	2.2	Grooved Tanner crab	0.8	Bigfin eelpout	0.4	Pacific hake	0.1
Bocaccio	2.0	Lingcod	0.6	Snailfish unidentified	0.3	Broadfin lanternfish	<0.1
Petrale sole	1.9	Splitnose rockfish	0.4	Rex sole	0.3	Spiny dogfish	<0.1
Number of hauls	12	Number of hauls	13	Number of hauls	12	Number of hauls	9
Species name	Stratum 5 915—1,097m	Species name	Stratum 6 1,098—1,280m	Species name	All Strata 183—1,280m		
Longspine thornyhead	69.7	Pacific grenadier	38.3	Dover sole	37.7		
Sablefish	27.7	Giant grenadier	24.7	Longspine thornyhead	34.6		
Dover sole	26.9	Grooved Tanner crab	24.0	Pacific hake	23.6		
Pacific grenadier	22.3	Sablefish	18.2	Sablefish	19.1		
Pacific sleeper shark	18.2	Longspine thornyhead	17.6	Pacific grenadier	10.5		
Shortspine thornyhead	16.4	Shortspine thornyhead	11.8	Grooved Tanner crab	10.4		
Grooved Tanner crab	15.7	Dover sole	9.8	Shortspine thornyhead	8.9		
California slickhead	13.4	Pacific flatnose	7.9	Giant grenadier	6.9		
Giant grenadier	9.1	California slickhead	6.6	California slickhead	4.3		
Deepsea sole	4.1	Black skate	2.3	Splitnose rockfish	4.3		
Black skate	2.1	Deepsea sole	2.1	Rex sole	4.1		
Pacific flatnose	1.5	Deepsea skate	1.8	Shortbelly rockfish	3.9		
Kamchatka eelpout	0.9	Brown cat shark	0.6	Chilipepper rockfish	3.2		
Black hagfish	0.9	Twoline eelpout	0.5	Pacific sleeper shark	3.0		
Twoline eelpout	0.8	Black hagfish	0.3	Longnose skate	2.3		
Brown cat shark	0.7	Blacksmelt unidentified	0.2	Sharpchin rockfish	1.9		
Blacksmelt unidentified	0.2	Pacific hake	0.1	Spotted ratfish	1.8		
Scarlet king crab	0.1	Kamchatka eelpout	0.1	Brown cat shark	1.8		
Pacific hake	0.1	Snailfish unidentified	0.1	Stripetail rockfish	1.7		
Robust blacksmelt	0.1	Scarlet king crab	0.1	Pacific flatnose	1.6		
Number of hauls	9	Number of hauls	11	Number of hauls	66		

Table 3.--Number of specimens examined for biological data during the 1991 west coast upper continental slope groundfish trawl survey of the INPFC Monterey area.

Fish species sampled	Otoliths, maturity, and weight data	Length-frequency data	Stomach samples	Fecundity samples
Arrowtooth flounder	1	5	—	—
Dover sole	582	694	119	—
Sablefish	495	2,869	104	—
Shortspine thornyhead	635	3,172	210	—
Longspine thornyhead	549	9,346	182	—
Shortbelly rockfish	—	230	—	300
Deepsea sole	—	684	60	—
Pacific hake	—	3,618	137	—
Giant grenadier	—	1,147	—	—
Total	2,262	24,301	812	300

Table 4.--Length-frequency measurements obtained from non-target species during the 1991 west coast upper continental slope groundfish trawl survey of the INPFC Monterey area.

Fish taxon	Length-frequencies
Black hagfish	434
Skates (4 species)	625
Sharks (4 species)	1,770
Other flatfish (4 species)	3,528
Other rockfish (18 species)	2,686
Other grenadiers (3 species)	793
Other roundfish (58 species)	10,536
Total	17,836

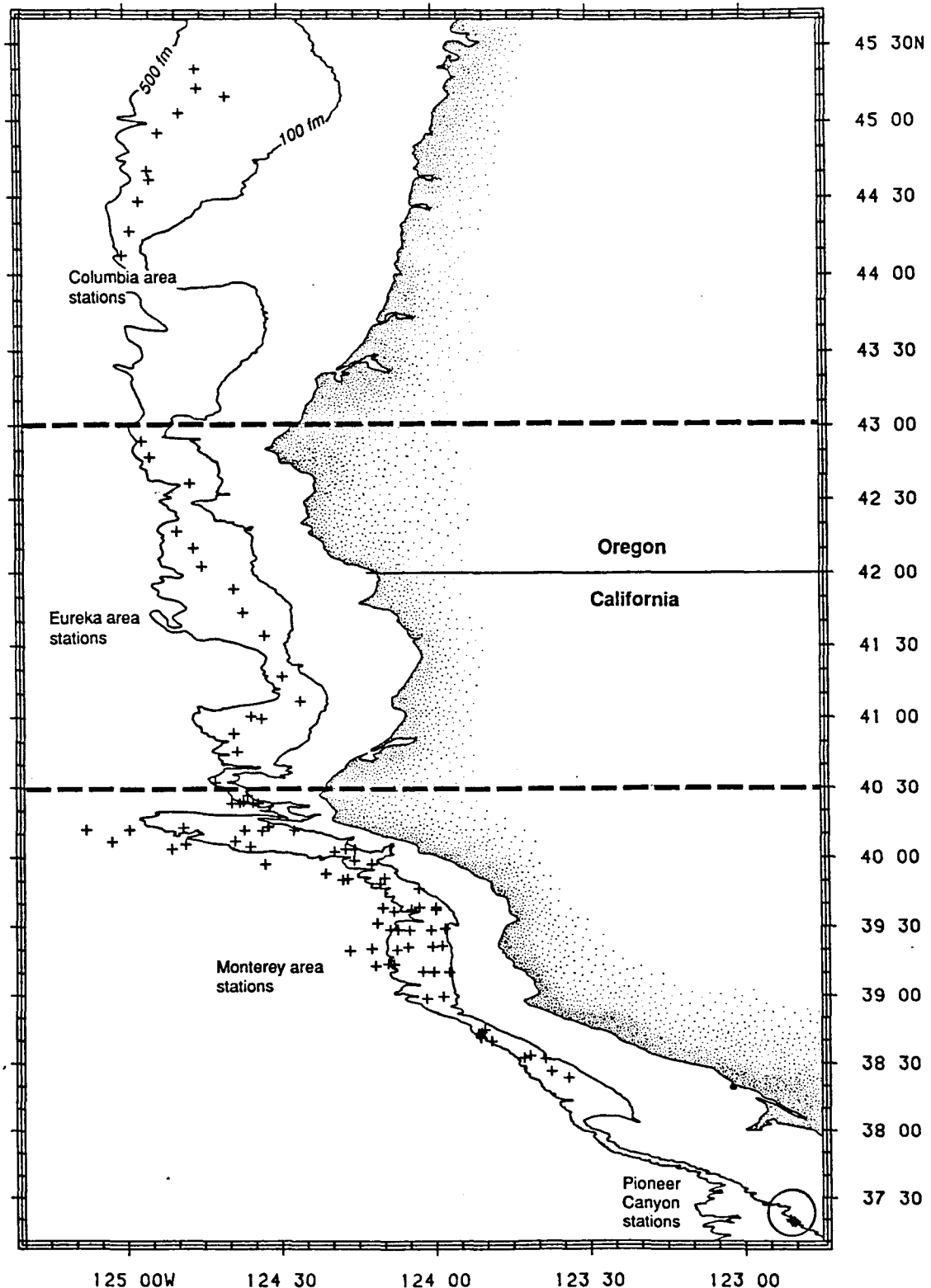


Figure 1.--Survey area showing the locations of the successful tows completed in the INPFC Columbia, Eureka, and Monterey areas during the 1991 Alaska Fisheries Science Center upper continental slope groundfish trawl survey. Width of figure is approximately three times wider than a standard mercator projection to more clearly show the location of individual stations. Equivalent depth intervals are: 100 fm = 183 m and 500 fm = 915 m.

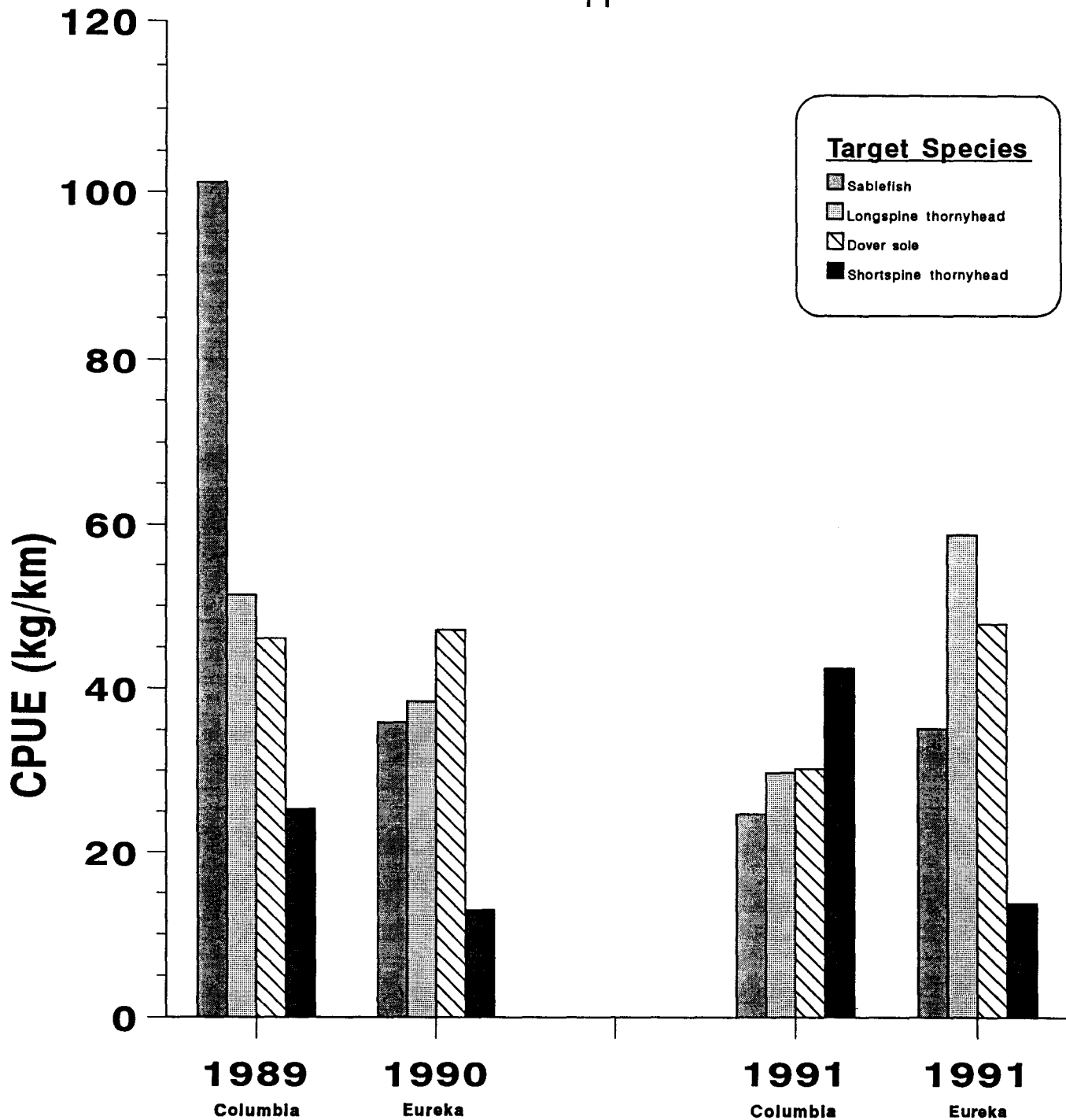


Figure 2.—Comparison of historical mean catch rates for the 550-732 m depth stratum with rates from the 1991 slope groundfish trawl resurvey of the INPFC Eureka, and Columbia areas.

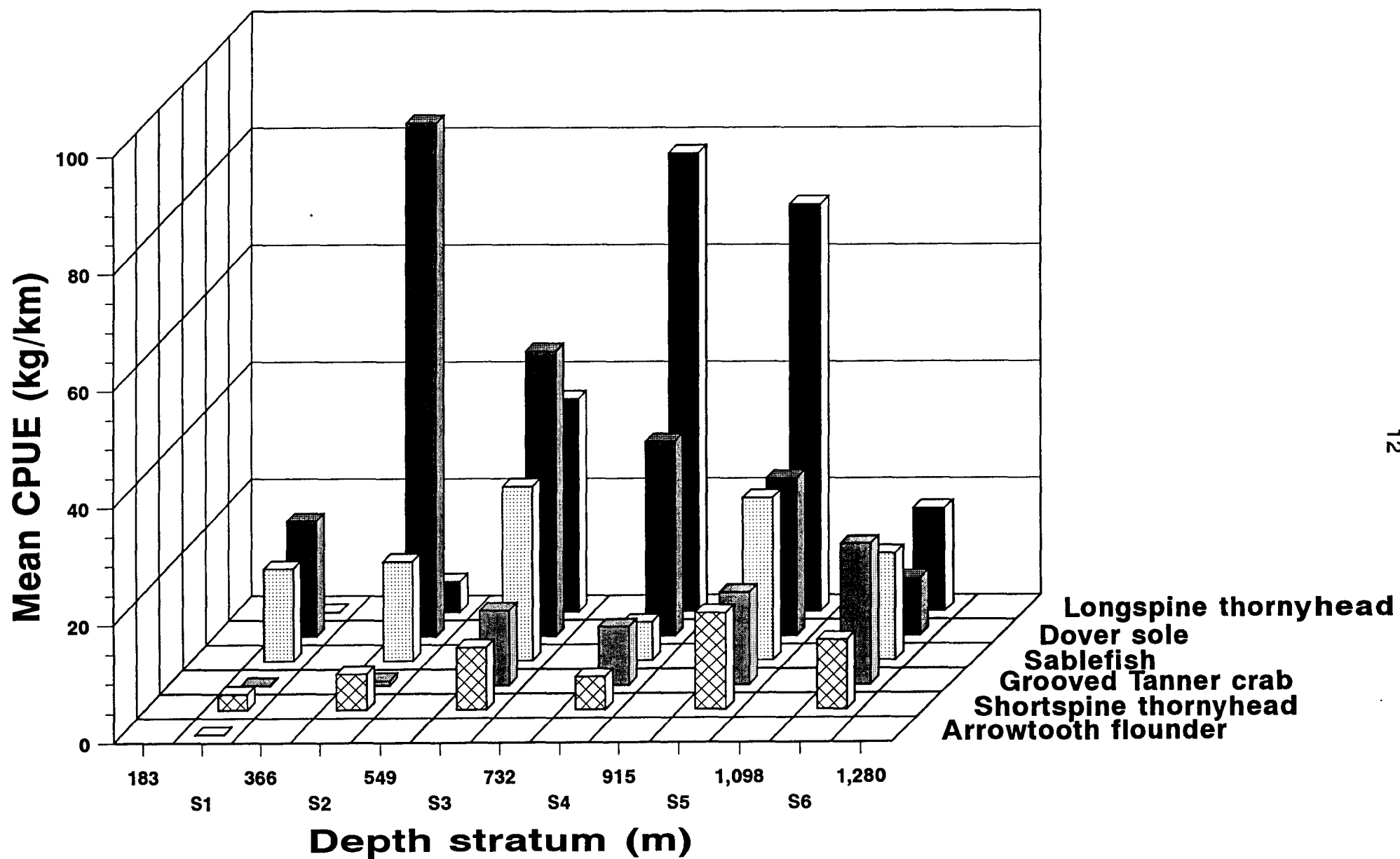


Figure 3.--Summary of the catch per unit effort (CPUE) distributions by depth stratum (S1-S6) for five target groundfish species and grooved Tanner crab during the 1991 INPFC Monterey area upper continental slope groundfish trawl survey.